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HEADLINE: Interregional spillovers in regional impact assessment: New Mexico, Texas, and the Supreme Court

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BODY:

Regional input-output models are often the tool of choice when economists are asked to estimate impacts, benefits or damages to some region from a past or future event. Yet a problem can arise from the fact that impacts spread according to the contours of the regional economy, while the methods used for impact estimation as well as the policy questions that motivate such analysis are often based on political regions. Political and economic regions frequently diverge. This paper shows that recognizing economic linkages across political boundaries is important for economic impact assessment. We will use the recent U.S. Supreme Court case of Texas versus New Mexico (U.S. Supreme Court 1987) to show that such cross-border spillovers can dominate the results of an impact analysis.

IRRIGATION IN THE PECOS RIVER VALLEY OF TEXAS AND NEW MEXICO

The Pecos River flows south through eastern New Mexico and the high plains of western Texas (see Figure 1 and Newman 1993). (Figure 1 omitted) The river and associated aquifers have been used for irrigating cotton, alfalfa, grains, chilies, melons, and pecans since the early part of this century. In 1948, growing conflict over the limited water supply led Texas and New Mexico to agree to the Pecos River Interstate Compact. In the recent case Texas alleged, and the U.S. Supreme Court agreed, that New Mexico had failed u, deliver to Texas all of the water called for by the Compact. The Court was left with the task of setting the compensation which New Mexico should pay Texas for damages on account of lost water.

The classic damage estimation approach initially argued in this case was a estimate the crops Texas could have grown had it gotten this water, and then use an input-output model of the Texas economy to estimate the direct and secondary income impacts of this production increment (Howe 1989). We argue that such an analysis is seriously incomplete because it fails to recognize the regional economic structure of the parts of Texas and New Mexico affected by the water maldistribution.

Irrigation is a consumptive use of the limited water in the Pecos Basin. To deliver more water to Texas, New Mexico would have had to reduce its water use. Models of hydrology and crop water use in the basin indicate that at least 20 acres of crops would be lost in New Mexico for each acre that could be irrigated in Texas. The 20 to 1 ratio is a consequence of the lags in the groundwater hydrology of the region, seepage and phreatophyte losses, and salinity buildup caused by evaporation and saline inflows in that section of the Pecos River.

The economies of affected parts of Texas and New Mexico are not independent of each other. Rather western Texas, and more specifically El Paso, economically dominates southeastern New Mexico. This means that western Texas would derive economic benefits irrespective of whether the water were used in southeastern New Mexico or in western Texas. The question is: What would have been the net benefits to Texas if it had gotten the water and the direct and

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secondary impacts which that implies, but at the cost of losing spillover benefits because of the associated reduction in New Mexico irrigated acreage?

CENTRAL PLACE THEORY AND REGIONAL MODELLING

Though economic impact assessment is often motivated by issues which focus on political regions, the impacts themselves spread not according to political divisions, but according to a spatial configuration of trade which is neither uniform nor random. Distinct economic regions exist, conditioned by trade patterns and characterized by predictably hierarchical patterns of cities, towns, villages and hamlets (Losch 1954 and Christaller 1966). At the top of the hierarchy are regional centers, offering a full array of goods and services and dominating all lower-order places with regard to provision of these items. Lower in the hierarchy the array of available goods and services progressively diminishes. Patterns of sub-dominance and sub-regions emerge. At the bottom of the hierarchy the lowest-order places, rural hamlets with little more than a post office and general store, dominate hinterlands of isolated homesteads. High-order places derive income from exporting commodities (often processed) outside the region, and from providing consumer and business goods and services to dominated lower-order places within the region. Lower-order places get their income from exporting agricultural and other unprocessed primary products outside the region or to higher-order places for processing and export. These hierarchically structured regions which form the separable functional units of the larger national economy are the functional economic areas of Fox and Kumar (1965). In addition to distinctive patterns of dominance and an internal balance of trade, functional economic areas are typically characterized by relatively closed markets for labor, consumer goods and business inputs. The hierarchical structure determines the internal workings of the region and conditions the transmission of economic impacts from one location to another.

The U.S. Department of Commerce, Bureau of Economic Analysis (BEA) (1975, 1981), has mapped the economic areas of the United States using concepts of central place, hierarchical trade, and closed labor and commodity markets. The result is a set of 183 functional economic areas covering the entire United Sates. This system of BEA Economic Areas, most consisting of several hinterland counties with a Standard Metropolitan Statistical Area at the center, has been used for compiling regional economic statistics and projections.

There is often a divergence between political boundaries (for which economic data is typically available and within which policy questions are typically framed) and functional economic area boundaries (within which economic activities actually determine the transmission of impacts from place to place). Thus, while the BEA areas follow county boundaries, they often cross state lines. The application of economic impact analysis methods is frequently hampered by this divergence.

State and county boundaries in the United States result from conditions and conflicts of a by-gone era; they are literally artifacts of the 18th and 19th centuries (see Fox and Kumar 1965). Political boundaries influence economic boundaries which are more fundamentally functions of geographic features, resource and population locations, and the transportation system. The Texas-New Mexico border has little basis in the geographic features of the area. The border is drawn through the middle of the "Llano Estacado" or "Staked Plain" that attracted cattlemen to the area in the mid 1800's. All of present eastern New Mexico west to the Rio Grand was vigorously claimed by the embryonic state of Texas between 1846 and 1950 as Texas fought to influence the terms of its admission as a state (Binkley 1925 and Larson 1968). As the issue escalated in an inflamed pre-Civil War atmosphere to include the contentious question of numbers of slave versus free states, the location of the border became a major national issue. In 1850 Texas actually attempted to organize local governments in the counties it designated in what is presently eastern New Mexico. The residents of the area now represented by El Paso-Pecos-Carlsbad-Roswell apparently acquiesced to this Texas connection. However the situation in Santa Fe-Albuquerque came close to an actual confrontation between Texas militia and Federal troops. At the national level the debates involved Henry Clay, Daniel Webster, Fredrick Douglas and John Calhoun. Since the nation was not yet ready for civil war, the "Compromise of 1850" chose the present Texas-New Mexico boundaries from a number of equally plausible alternatives, several of which would have left most of the Pecos drainage entirely within Texas. Texas gave up its claims to half of New Mexico and parts of Oklahoma and Colorado in exchange for the U.S. agreement to pay the $ 10 million debt accumulated by the Texas Republic during its war for independence from Mexico.

Given that the Texas-New Mexico border was based on political compromise rather than geographic features, it should come as no surprise that the border bears little relation to the present regional economy of the study area. The Texas counties of Reeves, Pecos, Loving and Ward (where the water would have been used had it been delivered to Texas) are part of the Midland-Odessa economic area, an area defined by BEA as being entirely within Texas (see Figure 2). (Figure 2 omitted) In contrast, the New Mexico counties of Chaves and Eddy (where the water in question was actually used for irrigation) are part of the El Paso Economic Area, along with most of southern New Mexico. According to the BEA, most of the remainder of eastern New Mexico is similarly influenced by the Lubbock and Amarillo Economic Areas. The Albuquerque Economic Area extends only to northern and western parts of New Mexico.

The parts of Texas and New Mexico of concern in this case cover a large area with few people. It is many miles from Pecos, Roswell, and Carlsbad to cities of much size (see Figure 3). (Figure 3 omitted) While distance is only one of several factors that determine the boundaries of the functional economic areas, the distances from Pecos, Roswell and Carlsbad to other regional centers reinforce the BEA delineation of economic areas in this region. In economic location theory, it is the highest order (usually the largest) central place that has the strongest attractive power, and greatest dominance. Using road mileage, Roswell is closest to Lubbock, and a bit farther but almost equi-distant from Albuquerque, Amarillo, Midland-Odessa, and El Paso. El Paso is by far the largest of these regional center cities. Carlsbad is nearly equi-distant from Lubbock, Midland-Odessa and El Paso. The trip to Albuquerque by car would take nearly two hours longer. Pecos, Texas, is closest to the Midland-Odessa center, and is next closest to El Paso.

There is a large measure of uncertainty regarding which economic area should be designated as containing distant hinterland areas such as Ward, Loving, Pecos, Reeves, Chaves and Eddy Counties. The boundaries of the functional economic areas that BEA was trying to represent are diffuse rather than the crisp lines drawn on the map. Given the distances, each of these counties must feel some degree of influence from several competing central places: El Paso, Lubbock, Amarillo, Midland-Odessa and even Albuquerque. Yet, for all its deficiencies, the BEA areas are a widely accepted first approximation of regions that can be used for analysis. The BEA areas provide strong evidence that significant economic ties link areas of New Mexico hinterland to higher order central places in Texas.

MODELLING IMPACT SPILLOVERS WITH INTERREGIONAL AND INTERCOMMUNITY I-O

Interregional or multiregional I-O models (see Miller and Blair (1985) and related interregional export-base modelling techniques (Chalmers et al. 1978) can be appropriate analytic tools in cases where spillover effects are important. They explicitly model the structure of two or more regional economies and the linkages between these regions. In this way the impact of an event in one region can be traced to all other regions. To illustrate the magnitude of the spillover impacts that can be revealed by such a model, it is useful to look at the example of a multiregional model constructed by Carter and Ireri (1968) as part of a study of the impact of California-Arizona water reallocation alternatives. Table 1 presents Carter and Ireri's results in terms of "spillover coefficients", defined as the ratio of the spillover secondary impact in the linked region to the secondary impact in the impacted region. (Table 1 omitted) The table shows the additional secondary impacts in California associated with each dollar of secondary impact generated in Arizona in response to an output change by each specified sec. These results indicate that for each dollar of secondary impact generated in Arizona, additional spillover secondary impact ranging from $ 0.058 to $ 0.822 (depending on which sector is impacted) will also occur in California.

Ideally the regions used in I-O analysis should correspond to functional economic areas or aggregations of such areas (Richardson 1972), and Robison and Miller 1988), an ideal met by neither the Carter-Ireri example nor the Pecos River situation. The state political regions used by Carter and Ireri do not closely represent the economic regional structure of the area. In the Pecos case, the true functional economic areas are cut by the state line. An ideal model for the Pecos would require that both the central place structure of the region and the state line be explicitly recognized. This integration of central place and I-O theory, through an intercommunity I-O model as in Robison and Miller (1991), would allow tracing the diffusion of secondary impacts through the central place hierarchy within each sub-region of the functional economic area. An intercommunity model constructed for the Pecos situation, a model explicitly recognizing that the state boundary splits the functional economic area, should show even higher spillover coefficients than those from the California-Arizona model. Time and funding limitations precluded building such a model. Adapted numbers from other studies are sufficient to illustrate the importance of spillovers.

The concept of interregional spillover within a central place hierarchy is another way of looking at economic "leakages" from these places. Generally smaller and lower-order places will have lower output and income multipliers because more spending leaks or spills into adjacent regions (Robison et al. 1993). Some models from Australia give a feeling for the magnitude of spillovers within a central place hierarchy. Table 2 presents output multipliers from a nested set of consistent I-O models presented in Hamilton and Jensen (1983). (Table 2 omitted) The small rural town of Toowoomba is contained within the Moreton Region, which in turn is part of Queensland, an Australian state.

As expected, Australia had the largest multipliers, averaging 1.71 across all sectors. Queensland's average multiplier of 1.55 is smaller because some secondary activity spills across its borders into other states. If we assume that each $ 1 of primary impact from some event in Queensland is actually associated with $ 0.71 of secondary impacts (the same average ratio as for events in Australia as a whole) then the fact that Queensland only captures $ 0.55 of these secondary impacts means that $ 0.16 of secondary impacts must spill over to other states. The ratio of spillover secondary effects to those captured by the region is the spillover coefficient, 0.16/0.55 = 0.291, for Queensland into the rest of Australia. Moreton Region, containing Brisbane the state capital, strongly dominates the economy of Queensland, allowing very little of the secondary impacts (only $ .01) from an event that occurs in Brisbane to spill into other regions of the state. In contrast, an event in Toowoomba generates 4.4 times more spillover secondary impacts in the rest of Moreton Region than in the local Toowoomba region itself, because it is such a small place and so strongly dominated by Metropolitan Brisbane. Moreton region is the functional economic area, and a large part of the secondary impact from events that occur in the small towns of its hinterland spill across any intervening political boundaries into the higher order places in the region. Similarly, the fact that the Pecos valley counties of New Mexico are hinterland to El Paso leads us to expect large impact spillovers across the state border.

IMPLICATION OF IMPACT SPILLOVERS IN THE PECOS RIVER CASE

The conventional approach to estimating Texas damages from he water shortfall would be to estimate the crops not grown in Texas and then the direct and secondary income loss associated with those crops net of the opportunity cost of the resources that would have been used in such production (see Howe 1987 and Hamilton et al. 1991 and 1993, and Hughes and Holland 1993). Given typical cropping patterns, prices and water use figures, the present value of Texas crop production for 1952 through 1986 decreased by an estimated $ 27.3 million because of water under-delivery by New Mexico (see Table 3). (Table 3 omitted)

The next step is to translate these production losses into direct and secondary income losses. However these estimates of lost income must be viewed as measuring "impact" rather than "damage". Estimating damages requires that we identify the opportunity cost of the resources displaced. Many of the factors (labor, capital, management) not used because of the water shortfall, were used instead in other areas of the regional and national economy. The ease with which resources find alternative employment obviously depends on the unemployment and mobility conditions in the economy, The local economy was quite buoyant during much of the period because of oil and natural gas production. In part reflecting this, we have assumed that the released factors could have earned at least 80 percent as much in alternative employment as they would have earned in uses supporting irrigated agriculture. This compares to a 69 to 94 percent figure used by Haveman and Krutilla (1968) in their studies of U.S. water projects and 80 percent used by Howe (1987) in his analysis of the Colorado-Big Thompson project. Distinguishing impacts from benefits and costs is discussed in more detail in Hamilton et al. (1991).

Crop budgets and resource specific estimates of opportunity costs were used to estimate the Texas net direct income loss of $ 7.9 million shown in Table 3 (if the land is not irrigated it is usable only for extensive grazing, but much of the capital and labor were probably used for non-irrigation purposes) (Whittlesey et al. 1989). The corresponding lost secondary income (estimated using I-O based multipliers) is $ 16.1 million (Hamilton et al. 1989). With the assumption that 80 percent of this lost secondary income is offset by alternative employment of the primary factors involved, this leaves net damages of $ 3.2 million to Texas attributable to lost secondary income. Thus a conventional analysis, ignoring the spatial structure of the affected region, would conclude that Texas suffered damages totalling $ 11.1 million ($ 7.9 + $ 3.2 million) because of the water shortfall.

In the same time period New Mexico grew irrigated crops with an estimated present value of $ 1,014.7 million using water which under the compact should have been delivered to Texas. The gross impact of using this water in New Mexico is much larger than the gross impact of losing the water from Texas due to evaporation losses, salinity buildup, and aquifer response time lags. This New Mexico crop production generated New Mexico secondary income (estimated using I-O based multipliers) with a present value of $ 557.9 million, or using the 80 percent factor, $ 111.6 million net of opportunity cost. However New Mexico did not capture all the secondary income from this crop production. Because the areas where this water was used are near the Texas border and contained within a functional economic area whose central place is a Texas city, much of the secondary impacts of using the water in New Mexico show up as spillover benefits to Texas.

Because we did not have the luxury of actually estimating these spillover impacts with an intercommunity I-O model that explicitly recognizes the trade links between the hinterland communities of Roswell and Carlsbad and the higher order central places of El Paso, Lubbock, Amarillo and Albuquerque, as well as links to even higher order metropolitan centers in Texas, we are left to speculate what such a model would show if it were built. Based on evidence from other models we have cited above, we would expect it to show quite high spillover coefficients, probably at least as high as 0.2 or 0.3. The Australian example presents an embarrassingly wide range of spillover coefficient possibilities from 0.019 to 4.40, but it does bracket our 0.2 to 0.3 figure. For the Carter-Ireri study, most of the spillover coefficients were around 0.1 or 0.2. Spillover coefficients for irrigation in the Carlsbad-Roswell area should be higher than that because of the closeness of the Texas border and because the border separates these production areas from the Texas central places at the core of their functional economic area.

If we conservatively apply a spillover coefficient of 0.1, then secondary impacts equal to 10 percent of total New Mexico secondary income net of opportunity cost would spill in Texas. The spillover secondary benefits to Texas resulting because the water was used in New Mexico would be $ 11.2 million, an amount sufficient to offset completely the direct and indirect income from the Texas crops lost due to the water shortfall! If, as is more likely, the true spillover coefficient exceeds 0.1, then the spillover benefits to Texas exceed its direct and secondary losses, and Texas is better off because New Mexico used the disputed water. Certainly the farm economy of the Pecos area of Texas was hurt by the water shortfall. However other Texas communities, most notably El Paso, benefitted from New Mexico's use of the water by as much or more than Pecos lost. The damages for which Texas was claiming compensation are either very small, or more likely are net benefits rather than net damages.

There are two other boundary issues. First, the nearness of the Mexican border (see Hansen 1981) raises the possibility that some spillover impacts may flow to Mexico rather than Texas. Second, our Australian example, since it deals with an island economy, might have fewer economic leakages and higher multipliers than a region with neighbors on all sides. While worthy of more attention, neither factor appears significant enough to affect the same conclusion, since a very conservative spillover coefficient was used here.

CONCLUSION

Recognizing and quantifying impact spillovers can be an important part of correct estimation of the economic impact of a policy or event. The Pecos case is unusual because of the disparity between the gross production effects in the two states. In many other cases however, where adjacent states compete for resources, for industry sitings, or for other development projects, or where the projects in question occur very near the regional boundary, the possibility of significant spillovers is very real. In such cases the use of interregional or intercommunity modelling approaches may be necessary in order to estimate the linkages and the resulting spillovers.

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